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AUTHOR Baird, John R.; White, Richard T.
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ABSTRACT

This paper reports a six month intervention program in two ninth grade science classes and one eleventh grade human biology class. One teacher, one researcher, and 64 students participated in this action research to improve student learning and attitude through training in metacognition. The researcher was a participant observer, who introduced materials and procedures for teacher and students designed to increase the students' awareness and control of their own learning. Materials included a Question-Asking Checklists to help students practice evaluation strategies during class, an Evaluation Notebook and Card, and a Techniques Workbook. The study had four main phases: (1) exploratory; (2) awareness; (3) participation; and (4) responsibility. The extensive data came from direct observations, audio and/or video recordings of classroom activities and student interviews, tests, and self-evaluations. It demonstrated changes in student and teacher behavior and in achievements and attitudes. Difficulties in presenting the extensive results of this new style of research have not yet been solved. A summary of evidence is presented on two outcomes: greater learner control over learning through effective decision making, and the teacher allowing more learner control. Recommendations for classroom practice and implications for the curriculum and school organization are drawn. (Author/BS)

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Improving Learning Through Enhanced Metacognition: A Classroom Study

John R. Baird

Melbourne State College

and

Richard T. White

Monash University

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Paper given at the meeting of the American Educational Research Association, New Orleans, April 1984

Improving Learning Through Enhanced Metacognition:

A Classroom Study

The paper reports a 6-month intervention in three secondary school classes. Students were trained in metacognition, with the intent that they would learn with greater understanding and have better attitudes to learning. The researcher was a participant observer, who introduced materials and procedures for teacher and students which were designed to increase the students' awareness and control of their own learning. The extensive data from direct observations, recordings, tests, and self-evaluations, demonstrate changes in teacher and student behavior and in achievements and attitudes. Recommendations for classroom practice and implications for the curriculum and school organization are drawn.

Improving Learning Through Enhanced Metacognition:

A Classroom Study

Certain deeply-held beliefs lie behind our commitment to this study. We see learning as the central concern of education, and consequently of educational research. Although learning is not to be interpreted narrowly, the acquisition and understanding of content is of prime importance. Learning without understanding is not useful. We believe that most people are capable of better learning than they currently demonstrate, and that improvement in learning is possible, socially and individually desirable, and indeed necessary. Only minor improvements in learning will come about through a search for new styles of teaching within the present style of teacher control. Substantial improvements depend on a fundamental shift from teacher to student in responsibility for, and control over, learning.

The study is the third in a series. The first two, which have already been published, were case studies of learning styles, which led to the much larger and more ambitious third investigation. In the first study (Baird & White, 1982a), three adult volunteers worked through a learning program on principles of genetics. They did this individually, in Baird's presence. Throughout the program they had to make written and oral responses to questions which were designed to elicit the strategies they used in learning. We observed two markedly contrasting styles. One, similar to Marton's (1975) deep-level processing and Pask's (1976) comprehension learning, involved active relating of new information to old, including knowledge that was not obviously part of the topic of genetics or even of biology.

The other was more task-directed, limited to responding to prompts and obtaining correct answers to questions asked. Because the understanding obtained through the first style seemed to make knowledge more accessible and useful in everyday situations, we judged it a superior method of learning.

Although in the first study one learner consistently demonstrated the first strategy and the other two the second, we appreciated that application of a style may be influenced by the learner's conception of the requirements of the task. In the second study (Baird & White, 1982b), therefore, we chose to operate in a more natural setting with three tertiary college students who were studying biology for credit towards a teaching qualification. We monitored their learning, and tried over 6 weeks of intense involvement to eliminate seven debilitating processes which we discovered in them: impulsive attention, superficial attention, inappropriate application of procedures, inadequate monitoring of own learning, premature closure, ineffective eradication of misconceptions, and lack of reflective thinking. Our experience led us to make five assertions about learning:

1. Learning outcome is determined by decisions made by the learner. These decisions are influenced by the learner's perceptions and interpretations.
2. Inadequate learning is due to ineffective decision making, which is associated with the seven deficiencies in processing already listed.
3. It takes energy to learn with understanding, or to unlearn a misconception.

4. Learners often are unaware of their deficiencies.

5. Increased learner awareness of the nature and process of learning changes attitudes and procedures.

Each assertion touches on metacognition - the knowledge, monitoring, and control of one's own learning. Metacognition is too complex a concept to be dealt with properly in a few lines. Extensive descriptions of it, or some of its aspects, can be found in Flavell (1976, 1981), Brown (1978, 1980), Moore (1982), and Cavanaugh and Perlmutter (1982). We mention it here merely to indicate the relation of our study to this body of theory. We postulate three levels in learning, of processing, evaluating the processing, and deciding. When the learner makes conscious decisions in association with the application of particular cognitive strategies, metacognition relates to at least the last two of these levels.

Cognitive strategies are broad skills for dealing with information of many types, not narrow techniques that can be applied only to limited areas of subject matter. One way of thinking about them is to define two major types, one of which is relatively subconscious and the other which is involved in metacognition. The less conscious ones are involved in the first step in learning, processing. Examples are strategies to gain access to memory, searching for and retrieving information; chunking information on spatial, semantic, or affective criteria; holding chunks in working memory and manipulating them; and applying rules automatically or inferring. The more conscious ones include many which can be termed evaluation strategies: ways of appraising, assessing, establishing, identifying, and checking knowledge. Evaluation strategies are the

focus of our research, for it is in them that we see the greatest potential for improving learning. In order to make them more specific, we list in Table 1 those we have thought of, together with examples of the conscious questions learners would be asking themselves when activating each strategy.

The seven debilitating processes we observed in the second study can be interpreted as failures to apply the strategies of Table 1. Thus impulsive attention is inadequate application of Evaluation Strategies 1 and 2, particularly 2.1; and premature closure is inadequate application of 7 and 8.

Our experiences in the first two studies led us to state a new purpose for the third: to train students in a natural setting in metacognition. We expect this to lead to better performances on a range of outcomes.

Others have already tried to improve metacognition. Brown and various co-workers (Brown & Barclay, 1976; Brown, Campione, & Barclay, 1979; Brown & Smiley, 1977, 1978) have attempted to train children in awareness and control of deliberate memorization skills. Novak and co-workers have used concept mapping and Gowin's epistemological V-mapping in attempts to enhance understanding of the nature of knowledge and how it is produced (Ault, Novak, & Gowin, 1980; Novak, 1980, 1981). Training in metacognition has been shown to result in improved study of text (Armbruster, Echols, & Brown, 1982; O'Loughlin, Brobat, Chernik, & Oehlsen, 1982; Weinstein, Underwood, Wicker, & Cubberly, 1979), particularly enhanced reading comprehension and recall

(Alvermann & Ratekin, 1982; Kendall & Mason, 1982; Loper, 1980; Tierney, 1983); problem solving (Quinto & Weener, 1983); and oral comprehension (Robinson & Robinson, 1982). Recent learning skills programs include instruction on metacognition (e.g., Huhn, 1981; Dansereau, McDonald, Collins, Garland, Holly, Diekhoff, & Evans, 1979). However, in these studies and programs the learners are limited to following instructions or protocols. Most programs do not train students to take responsibility for and control over their own learning (Brown & Palincsar, 1982; Gibbs, 1981). Consequently, generalization and transfer effects are limited. Tobias (1982) has questioned the extent to which students adapt learned strategies to suit themselves and the requirements of different subject matter. There is a distinction between the process of strategy application and the outcome of metacognitive awareness and control. When strategies are taught and used mechanically, the label metacognition is inappropriate. Our theme is that the application of the Evaluation Strategies of Table 1 must be conscious and purposeful. That application does not come easily; it must be practised.

These reflections on related research, in combination with the general purpose of the study, led us to set seven objectives for the learners who were to take part.

1. Increased knowledge of the elements of metacognition.
2. Enhanced awareness of their learning styles.
3. Enhanced awareness of the nature and purpose of tasks.
4. Greater control over learning through more effective decision-making.
5. More favourable attitudes to learning.

Table 1

Tentative Classification Scheme for Some Evaluation Strategies Involved in Learning Written Information

Strategy type and number	Nature of strategy	Examples of questions which would direct strategy application
Group A.	Evaluation Strategies associated with decisions about information reception, processing to establish meaningfulness, and subsequent processing approach	
1.	Receive information	
1.1	Establish general topic, activate appropriate content-related schemata.	What is this all about? What does this involve? What does this relate to?
1.2	Evaluate:	
	general nature and extent of knowledge and understanding for these schemata;	How much do I know about ... ?
	affective features of these schemata (previous history of success or failure, level of interest, attitudes, beliefs.)	What are my feelings about ... ? e.g., How important, interesting ... is it?
2.	Establish meaningfulness	
2.1	Review message structure. Select particular area(s) of communication for attention.	Have I read the information carefully and fully? What are the most important parts of this? What should I concentrate on?
2.2	Select most salient aspects of activated schemata which are needed to interpret and process the information; check understanding of these aspects.	How does this relate to my knowledge of ... ? What do I need to remember about ... in order for this to make sense?
2.3	Relate message areas to each other to increase meaningfulness.	How is ... related to ... ?
2.4	Appraise adequacy of personal knowledge for comprehending information; determine overall level of meaningfulness and difficulty.	Do I know enough about ... in order to understand this? Is the meaning clear? Is this information consistent with what I know?
3.	Define task and establish processing required	
3.1	Establish nature and requirements of the activity. Confirm that the demands (e.g., questions asked) are appropriate to, and consistent with, the nature of the communication.	What am I required to do? Does it seem reasonable in terms of the information given?
3.2	Generate expectations regarding types and extent of processing required, and likely outcomes.	What will I have to do in order to complete the task? How long will it take? How hard will it be to complete? What do I predict is going to happen?
4.	Consider advantages and disadvantages of alternative approaches (cost-benefit evaluation)	
4.1	Check possible alternative approach and processing methods.	What is another way I could approach this? How long would this take? How difficult would this be to use?
4.2	Evaluate affective responses to the task.	Why am I doing the task? How important, relevant, interesting is it? What will I get from it? What use will I make of the result? How likely is it that I'll obtain the correct answer, or complete the task successfully? What if I don't do it?
4.3	Evaluate 'readiness-to-learn' factors.	Do I feel like learning, concentrating? What else do I have to do? How does this task rate in priority?

contd....

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Table 1 (contd.)

Strategy type and number	Nature of strategy	Examples of questions which would direct strategy application
Group B.	Evaluation Strategies associated with decisions regarding ongoing information processing: choice and mode of application of appropriate rules, intellectual skills, and schemata; modifications to existing cognitive structure; extent of processing	
5.	Monitor processing	
5.1	Contrast new (received or generated) information with specific memory elements: evaluate nature, validity, salience.	How does this new information compare with what: I used to think? I predicted would happen? What effect does this new ... have on my understanding of ... ? Does this mean I have to change my understanding of ... ?
5.2	Monitor general level of comprehension by reference to known.	Do I understand what I am doing? How clear or sensible is all this? Does this seem correct?
5.3	Evaluate appropriateness, and potential and ongoing productiveness, of different ways of manipulating information to fulfil purposes.	What should I do next? Is this the best way of proceeding? Am I checking all possibilities? Where will this approach lead me? What do I predict will happen?
6.	Elaborate knowledge and understanding ('reflective thinking')	
6.1	Elaborate meaning and significance of new information by reference to content-related structure (i.e., check boundaries, conditions of validity or relevance; establish or clarify associations between elements.)	What if some factor were changed? What if ... were twice as large? When does it not apply? How does it relate to ... ?
6.2	Elaborate meaning and significance of new information in terms of 'external' cognitive structure (i.e., form novel associations between diverse structural elements: relate to real world knowledge; apply in new situations; invoke analogies, sensory or perceptual links) - includes 'divergent' thinking, creativity.	What if ... ?
7.	Complete processing	
	Evaluate new information in terms of perceived task requirements.	How does this information relate to what is required? Have I answered the question? What else needs to be done, if anything?
Group C.	Evaluation Strategies associated with decisions regarding outcome	
8.	Evaluate outcome	
	Evaluate outcome in terms of personal considerations, including cost-benefit aspects.	Do I really understand this? What do I have to do in order to achieve full understanding? Is it worth it? If I don't fully understand it, do I understand enough to justify stopping? (i.e., am I sufficiently satisfied with the result that I can justify moving on to something else?)
9.	Evaluate revision of cognitive structure and function; establish context for future learning	
9.1	Evaluate the extent to which changes to cognitive structure or function resulting from current learning are being achieved.	Am I using or applying my revised understanding of ... ? How can I remember to replace ... by ... in future?
9.2	Establish context for future learning.	How does this outcome relate to future activities, i.e.: What do I have to do next? Will this result enable me to continue? What use will I make of this result? How should I try to remember this?

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6. Higher self-set standards for understanding and performance, and more accurate self-evaluation of attainment.
7. Becoming a more effective independent learner, by diagnosing and overcoming difficulties using class and private time productively, and planning activities thoughtfully.

We also had three objectives for the learners' teacher.

1. Increased awareness and understanding of the process of learning.
2. More favourable attitudes to learner control of their learning.
3. Adoption of behaviour allowing greater learner control of their learning.

Each objective was a focus for the collection of certain data and their interpretation. In the collection we were as much concerned with how any improvement occurred as with obtaining it.

The general style of the investigation was a case study of learning in a natural school setting. In adopting this style, we were influenced by Power's (1976) criticisms of the "agricultural-scientific" paradigm for educational resarch, and Easley's (1982) arguments that generalizations are possible from case studies.

Easley states "the studies of individual pupils give you an awareness of the kinds of processes that are going on in children's minds so that when you see a child engaged in some task you are more interested and more able to understand it" (Easley, 1982, p.200).

Since our aim is not only to understand children's learning processes but to bring the children themselves to that understanding and hence control, it was appropriate to involve the children in the study as researchers; that is, the study should be action-research. There were three sorts of participant in the action-research: the researcher, the teacher, and the students. In action-research the emphasis is on the first person: I observe, I collect information, I reflect, I evaluate, I act, I clarify, I am active. These activities, this responsibility, are consistent with what we were trying to achieve, and are the antithesis of a conteptualization of learning which emphasizes external control, dependence, and receptivity. Thus the research was, in effect, itself the treatment.

A further reason for choosing action-research is that the general aim requires elucidation of the processes of learning. These are mental events, internal and unobservable. They can be studied through reports on introspection and through influences from observable acts. Both approaches are criticisable. Brown (1980) observes that not all processes are open to introspection; and the link between behaviour and internal event is complex - failure of a learner to behave in a particular way may reflect lack of strategy or merely unwillingness to apply it at that moment. The three-focus action-research is an attempt to minimise the shortcomings of these methods. Researcher, teacher, and learners were to join in interpreting behaviours and drawing and sharing inferences about the cognitive processes behind specific events. Consequently all participants had to understand the purpose of the study, the

learners had to practise introspection and be supported in it, and the learners and the teacher had to join the researcher in evaluating behaviours.

Procedure

Location, Duration, and Participants

The study took place in one Melbourne suburban high school. It began in June 1982, and continued until December 1982. It involved one researcher (Baird), one teacher who is given the pseudonym of Mr Atkin, and 64 students who were in two grade 9 Science classes and one grade 11 Human Biology class.

Mr Atkin had had 19 years experience in secondary schools. He has an excellent reputation for teaching ability, and has had experience in training teachers of science and biology.

Mr Atkin was responsible for teaching the three classes. Both grade 9 classes had four 50 minute lessons a week, and the grade 11 had five. Baird attended all of the lessons for one grade 9 for 2[illegible] weeks and three-quarters of them for the other. He spent less time with the grade 11, just short of half the lessons for 16 weeks.

Materials

The materials designed to assist students to increase control over their learning were a Question-Asking Checklist, An Evaluation Notebook, and a Techniques Workbook. A copy of each was provided for each student.

Question-Asking Checklist: The Checklist is shown in Figure 1. It is designed to help students practise evaluation strategies during class. It has three sections. Section A addresses the topic and task and decides on the approach: B monitors progress and consolidates understanding; and C evaluates understanding and establishes the context for future learning. The notion behind the Checklist is that if learners adopt a questioning approach to learning they will overcome the seven deficiencies identified in the second study. The questions in sections B1 and B3, for instance, are aimed against the deficiency of inadequate monitoring. Use of the questions shifts some of the responsibility for learning from the teacher to the students.

Evaluation Notebook and Card: The Notebook is a bound exercise book, in which students were to write evaluations of their learning behaviours and outcomes in lessons and private study. The evaluation was to be guided by the Card (Figure 2) which was to be placed alongside a page on which the student would write an assessment opposite each key word of the Card. Usually a tick or a cross or a brief assessment would be sufficient. The evaluation was to be made in the final minutes of each lesson.

Techniques Workbook: The Techniques Workbook is another bound exercise book, planned for use in trials of study techniques. As it turned out, it was used solely for concept mapping.

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QUESTION-ASKING CHECKLIST

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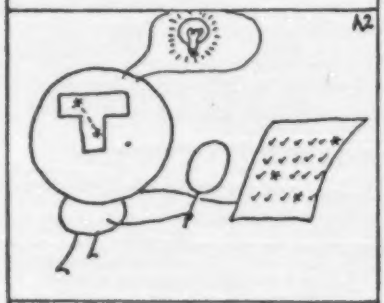
A

TOPIC ?

- What is information about ? - What is the topic ?
- What do I know about the topic ? (T)
- What does the topic relate to ?
- How do I feel about the topic ?

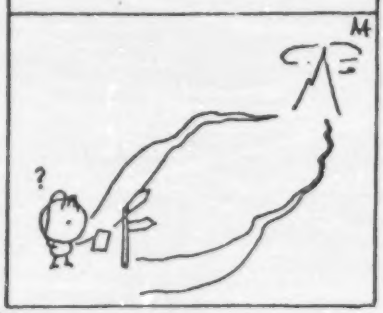


DETAIL ?

- Have I read the information fully and carefully ?
- What are the most important parts ? (*). How do the parts relate to each other ?
- Does the information make sense ? What do I have to remember, or find out, in order for it to make sense?

TASK ?

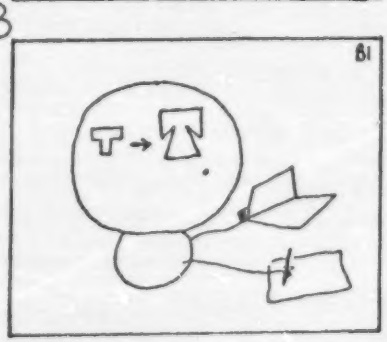
- What is the task ? - What is required ?
- What will I need to do in order to complete the task?



APPROACH ?

- How will I approach the task ?
- How hard will it be ? How long will it take ?
- Is there another way of doing it ?
- Why am I doing the task ?
- What will I get from it ?
- What use will I make of the result ?

B



CHANGE IN KNOWLEDGE ?

- How does this new knowledge compare with what I used to think ?
- Does this new knowledge affect other things I know?

contd...

Figure 1. Question-Asking Checklist.

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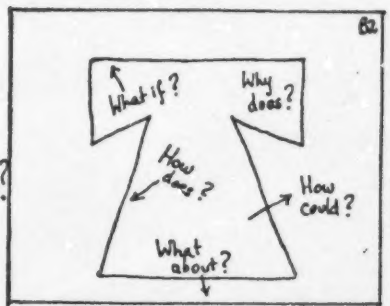
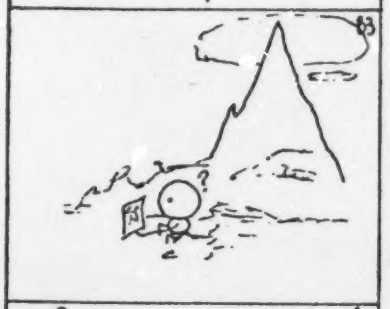
INCREASE UNDERSTANDING?



- What if ... ?
- How does ... ?
- Why does ... ?
- How could ... ?
- What about ... ?

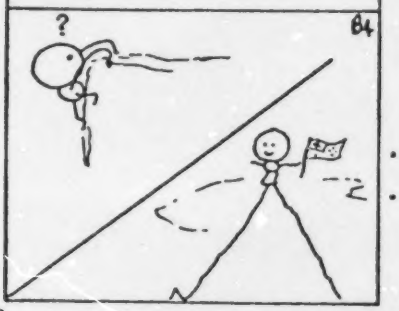
etc.

PROGRESS ?



- How am I going? Is it as I predicted ?
- What am I doing? Why am I doing it?
- Where will this approach lead me?
- Is it the best way of proceeding?
- Am I checking all possibilities?

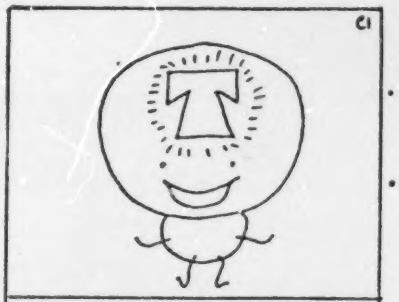
COMPLETION ?



- Have I answered the question, or completed the task?
- Does anything else need to be done?

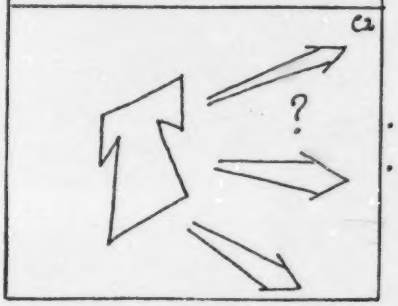
C

SATISFACTION ?



- Do I fully understand this? Do I understand enough to justify stopping?
- What do I have to do in order to achieve full understanding? Is it worth doing?

FUTURE USE OF KNOWLEDGE ?



- How can I make sure I remember this knowledge?
- What's coming up next? What use will I make of this new knowledge?

Figure 1 (contd.). Question-Asking Checklist.

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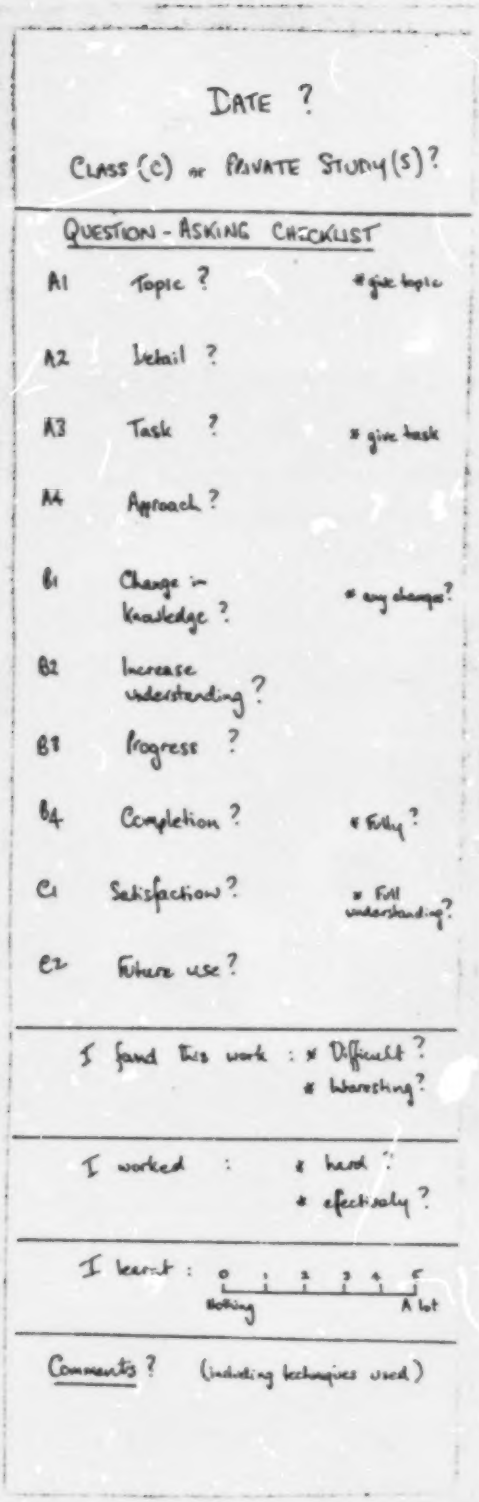
DATE ?
CLASS (C) or PRIVATE STUDY (S)?
QUESTION - ASKING CHECKLIST
A1 Topic ? * give topic
A2 Detail ?
A3 Task ? * give task
A4 Approach ?
B1 Change in knowledge ? * any change?
B2 Increase understanding ?
B3 Progress ?
B4 Completion ? * fully ?
C1 Satisfaction ? * Full understanding?
C2 Future use ?
I found this work : * Difficult ?
* Interesting?
I worked : * hard ?
* effectively ?
I learnt : 0 1 2 3 4 5
Nothing
A lot
Comments ? (including techniques used)

Figure 2. Evaluation Card

Phases

The study had four main phases.

Phase 1. Exploratory (4 weeks with each of grades 9 and 11). Baird examined preintervention attitudes, behaviours, and performances of teacher and students, achieved rapport with them, and gained their consent for cooperation and participation.

Phase 2. Awareness (5 weeks with grade 9, 3 weeks with grade 11). Action-research began. Students were given opportunities to enhance their awareness of the process of learning, and of their personal attitudes to learning and their characteristic ways of going about it. Students were involved in defining their learning difficulties and in reflecting on ways of overcoming them.

Phase 3. Participation (7 weeks with grade 9, 6 weeks with grade 11). At the beginning of Phase 3, five students were chosen in each class for special observation. The selection was by stratified random sampling, based on prior subject performance. The students were not informed of their selection. All students, not just the selected 15, began to use the Question-Asking Checklist, the Evaluation Notebook and Card, and the Techniques Workbook. In the middle of the phase, students were found to be not making good use of the materials, partly because of teacher control of the pace and direction of lessons. Baird intervened, despite concerns for the naturalness of the study, to discuss procedures with students and teacher and to recommend changes. Throughout the phase the teacher

examined his approach to control, encouragement of responsibility for learning, and attitudes to the study. Observations intensified (see section on Sources of Data).

Phase 4. Responsibility - Control (7 weeks with grade 9, 3 weeks with grade 11). Phase 3 involved frequent minor intervention by Baird to help students with use of the materials. This ceased in Phase 4, in which students and teacher monitored independently their attitudes, procedures, and techniques, and reflected on developments. Observations continued at high intensity.

Sources of Data

Data were obtained in 15 ways.

1. Evaluation Notebook. For most lessons in Phases 3 and 4 each student assessed the use of questions from the Question-Asking Checklist, using the Card of Figure 2 to enter the measures in the Notebook.

2. Techniques Workbook. The Workbook contained concept maps which the students constructed in Phase 3. Grade 9 made two, both on "Skin". The first was undirected: the students wrote all the words they could think of which were related to skin and used them in their map. Following discussion of these maps, a second one was made using words selected by Baird. Grade 11 followed the same procedure for "Micro-organisms".

3. Class observation. During or immediately after each lesson Baird observed, he wrote up notes in a daily diary. He highlighted major issues in a weekly review. Phases 1-4.

4. Audiorecording of lessons. Of the 180 lessons Baird attended, 145 were recorded. Phases 1-4.

5. Audiorecording of class discussions of the project. On seven occasions Grade 9 and on five occasions Grade 11 discussed the purpose and progress of the study. Discussions varied in length, usually between 10 and 30 minutes. Phases 1-4.

6. Audiorecording of interviews with individuals. Interviews were held in private to determine attitudes to, and perceptions of, learning. During Phase 1 or early in Phase 2, 10 minute interviews took place with 62 of the 64 students. In Phases 3 and 4 more interviews were held at irregular intervals, concentrating (but not exclusively) on the students who had been selected for special observation. This second round of interviews was partly to obtain information about the students' beliefs, and partly to help them focus on the objectives of the study. The teacher was interviewed 27 times, for periods of 15 to 90 minutes, over Phases 1 to 4.

7. Audiorecording of conversations with students in class. During Phases 3 and 4 Baird recorded all conversations he had with students as he moved round the classroom during lessons.

8. Audiorecordings made by students. In Phase 4 Grade 9 students spent the last 3 weeks of the study working in groups (12 in all) on Option sections in the ASEP unit "How many people?" Each group recorded its discussions for the whole of the six (9C) or seven (9D) lessons that were spent on the activity.

9. Video recording of a lesson. In Phase 4 a double lesson of 9C was videotaped to record normal classroom behaviours, manner of use of the Question-Asking Checklist and the Evaluation Notebook, and interviews with individual students, and the teacher on perceptions of the lesson and of study materials.

10. Video recording of chemicals task. In Phase 4, Grade 9 students attempted, individually, Piaget's coloured chemicals task. Videotapes were made of 16 students, including 9 of the 10 selected for special observation.

11. Questionnaires. In Phase 2 the students completed questionnaires designed to assess their perceptions of their understanding and performance. Grade 9 completed questionnaires before and after doing a test by the teacher, Grade 11 after a test. Later in Phase 2 all students completed a questionnaire on their feelings about the study. In the final week of Phase 4, Grade 9 students evaluated the study.

12. Evaluation of personal learning. Although designed principally as a training activity and part of the students' action-research, this evaluation was also a source of data. Early in Phase 4 the students constructed learning profiles for different periods of the study from the entries in their Evaluation Notebooks, and then wrote evaluations of themselves as learners, including comments on changes between their early and late profiles.

13. Categorization of student role. In Phase 3 Baird began to assess each lesson on a four-point scale, according to the role of a typical student. The four points are:

I. Informed Collaboration

Students collaborate actively with the teacher and share responsibility and control for the nature, purpose, and progress of the lesson.

Students attend to questions on the Checklist, and reflect on and determine answers.

All contributions (questions, answers) are valued by the teacher and, as far as possible, considered critically by the class.

II. Informed Participation

Students participate actively according to teacher directions.

Teacher assumes responsibility and control for lesson nature and development.

Students attend to questions as on the Checklist and are aware of, or actively engaged in, finding out answers. However, students do not determine procedures such as "Approach".

All contributions are valued by the teacher and, as far as possible, considered critically by the class.

III. Relatively Uninformed Responding

Students participate actively, but mainly when directed, by answering teacher questions or performing set tasks.

Teacher controls the lesson.

Students do not fully comprehend lesson nature, purpose - or progress - there may be insufficient time, encouragement, or student inclination to ask and gain answers to many of the questions on the Checklist.

Some students' questions or answers are valued more than others by the teacher.

IV. Passive Receptivity

Responsibility and control of the lesson is wholly the teacher's.

Student work is limited to passive, undemanding roles such as giving superficial responses, transcription of work, etc.

Students do not fully comprehend lesson nature, purpose or progress.

Lack of time, encouragement, or student inclination to ask and gain answers to many of the questions on the Checklist.

Evidence of day-dreaming, off-task activities.

During Phase 4 the teacher and all the students joined Baird in assessing, independently, some lessons on this scale. The teacher also reported the evidence from the lesson which had the greatest influence on his choice, and commented on his satisfaction with the lesson.

14. Estimating productive inquiry. The Options lessons for Grade 9 in the last 3 weeks of Phase 4 involved student-centred activities with little direct control by the teacher. The students estimated the extent of the inquiry that occurred and also how productive it was. The evaluation was based on the Question-Asking Checklist, using the number of questions asked and an estimate of the proportion that had been answered successfully.

15. Tests set by the teacher. During the 6 months of the study the teacher assessed the Grade 9 students through three tests, practical reports, a report on an activity in which students were to find the factors influencing the period of a pendulum, and an oral presentation and written group report on the Options work. Grade 11 students were assessed by two written tests.

Results and Conclusions

This is a very different style of research from the laboratory-experimental style of the 1960s, in which mean test scores for different treatment groups could be presented in a single table, and an analysis of variance on other statistical procedure used to back up the conclusions. There are problems in presenting the results in this new style, which we have not yet solved. In this study, we have two difficulties. One is that there is not a one-to-one

correspondence between the 10 objectives (7 learner, 3 teacher) and the 15 sources of data. For instance, information on the learners' awareness of their learning styles is provided by the Evaluation Notebook, audiorecordings of interviews and of class conversations, the Evaluation of personal learning and the Estimation of productive inquiry. Coming the other way, Classroom observation records provide evidence about almost all of the objectives. Our other difficulty is the mass of data.

We are still trying to overcome these difficulties. At the present time we have managed to reduce the data to a 200 page report, but obviously need to go further before the results can be communicated easily. To illustrate the sorts of evidence that we have collected, we concentrate here on only two outcomes, the vital one of greater learner control over learning through effective decision making and the teacher allowing more learner control. We present a summary of evidence bearing on those outcomes, then the overall conclusions from the study.

Evidence Bearing on Learning Control of Own Learning and of Lessons

We summarise evidence from three periods of the study: Phase 1, when the existing behaviours were recorded; Phase 3, not long after the active intervention had begun; and through Phase 4, when we anticipated changes in behaviour should appear.

Phase 1. The message from all forms of data, and all sources - researcher, teacher, students, is clear: at this stage students had hardly any control over the direction of lessons, or over their own learning in any positive way.

The relation between lack of control over lessons and lack of control over learning is illustrated by a Grade 11 student: "I try to understand in class, but it is just that he goes on really fast ... and then you feel funny asking questions because you might seem dumb." Apparently that was a common feeling. A random selection of six students from each of the upper, middle, and lower achievement groups (determined by previous school science assessments) in each class was asked in a questionnaire, "Have you ever found in Science (Biology) that you are asked to move on to another topic before you have really understood the topic you are doing?" The responses are reported in Table 2.

Table 2

Numbers of Students Saying They Have Been Moved To Next Topic Before Understanding

	Grade 9			Grade 11		
	Upper	Middle	Lower	Upper	Middle	Lower
Yes (a lot, often)	1	4	2	1	0	3
Sometimes	5	7	10	5	6	3
No	6	1	0	0	0	0

Baird's observations led to the conclusions at this time that the students were dependent and receptive, the teacher dominant. The teacher had good rapport with the students, but planned, initiated, and directed lesson activities. When students were asked "What are you doing?", most had only a limited idea. When asked "Why are you doing it?" only about two students per class could explain clearly in terms of topic development. Other answers included "Because

that is what the book says to do," and, most commonly, "I don't know." The students asked few questions, and those they did ask revealed their perception that the teacher controlled lesson direction and content meaning: "What do you want me to do?" "What's wrong with what I wrote?" "Can you give me a revision sheet?"

Learning was perceived as something enforced externally, and limited to prescribed task boundaries. When asked about study habits, a Grade 9 student said "In maths, just read the book, in English do what the teacher wants, same in science."

Lack of control over lessons and learning was observed to result in several activities that were essentially meaningless to the students. An example is a Grade 9 activity with an ASEP unit, "Skin and clothes." The students were required to examine through a microscope a vertical section of human skin, and to compare what they saw with a three-dimensional block diagram in their booklet. The teacher asked them to prepare a composite diagram representing the structure of skin, from the microscope slide and the diagram. The students could not see any relation between the slide and the diagram, so most made an exact copy of the diagram without referring again to the slide. In conversations many students acknowledged that the microscope section was not meaningful for them, but none asked questions such as "How does the section compare with the diagram?" or "Why doesn't it look the same as the diagram?"

The students were not apathetic. They said they wanted to improve. In the interview, 29 of the 36 randomly selected Grade 9 students answered "No" to the questions "Are you satisfied with how well you are going in Science?", and 30 answered "Yes", and 6 a qualified "Yes" to the question "Do you want to improve?" The corresponding numbers for the Grade 11 class were 14 out of 18, and 15 and 2.

One reason why they did not improve is that they did not know how to. They were asked "What do you think you need to do, or to fix up, in order to do better in Science (Biology)?" We classed the answers as either general or specific. In the former, the students showed only a vague notion of the required change. The most common answers in this group were to study more and to work harder. Specific answers included to listen more carefully in class, to improve spelling, and to ask more questions in class. From the 36 selected Grade 9 students we got 36 general answers and 29 specific; from 18 Grade 11 students 17 general and only 8 specific, 6 of which were to listen more carefully. Most of the specific answers in Grade 9 came from the more able students. We appreciate that this is not an easy question to answer straight off. Nevertheless, the answers lead us to conclude that many students do not have a clear perception of particular learning difficulties, nor a purposeful approach for overcoming them, and that senior students may be no more informed or purposeful than junior.

A second reason why the students did not change their learning styles is that the way the classroom was run prevented them. The teacher expressed agreement with the aim of making students more responsible for their own learning and for having them ask questions. Mr Atkin: "That's the key thing, they have got to be given that chance, to get to grips with their own learning, to get into control of their learning." He was aware that the students took little initiative: "Year 11 might be a bit frightened to express their independence ... they tend to want to conform more to what they think our expectation of them is ... e.g., 'What do you want us to say?'" However, it was clear that he was in control. "I run a fairly formal classroom, with a fair amount of effort to promote kids' thinking ... I promote thinking rather than facts in a ... well-structured classroom." Baird: "Do they ask questions a lot?" Mr Atkin: "No ... I'd like to see them ask a lot more questions but I don't think the teacher-pupil classroom situation really lends itself to kids asking a lot of questions that are peripheral ... it's really a very engineered situation" and "The students are not taking a great deal of active decision making on where they are going, or why they are doing it."

Phase 3. Phase 3 saw the beginning of active attempts by all participants to change learning behaviours and to shift some control over lesson direction and pace to the students. The written evaluations Mr Atkin made of lessons showed Grade 9 demonstrating more change in control of their learning than Grade 11: "Steady flow of help between pupils, and they asked questions"

(9D, week 3). "Readily asked questions" (9C, week 3). "Occasionally asked me a question as I walked round the room" (9C, week 4). "Very few questions asked, pupils unable to answer my revision questions. Very disappointed in their response" (11, week 3). "Very few questions from them" (11, week 4). "Many pupils ... do not try to summarise or clarify notes or diagrams. Do not know the meanings of words" (11, week 5). "Blindly accept what they are told ... seem unable to think ... straightforward transcription is OK for them" (11, week 5).

The Evaluation Notebook entries show that students were asking questions of themselves at this time. In Grade 9 60% and in Grade 11 75% of students claimed to have asked five or more of the ten types of question in all lessons. The least frequently asked questions were A4 (Approach) and C2 (Future use) (see Figure 1), perhaps because those aspects were perceived to be under the teacher's control. Baird checked the validity of Notebook entries by means of class conversations and interviews.

From week 2 on, students were observed to ask the teacher questions of a type not previously seen: "Why are we doing this?" "What are we doing next?" What has this got to do with ... ?" These questions were more common in Grade 9.

There was an occasional negative note: Mr Atkin, in conversation: "I've got the feeling that the vast majority of kids never ask (evaluative) questions. They are doing (the work) because they are told to do it." And an occasional

unexpected positive one: the Grade 9 Geography teacher commented that the students now asked, unprompted, many questions of an insightful nature. They were studying traffic in the road outside the school, and the students asked questions including "Why are more cars travelling North than South?" and "Why is there less traffic from 9.22 to 9.52 than from 10.07 to 10.37?"

In the first half of Phase 3 we were not satisfied with the use made of the training materials, and after discussing the progress of the study with the teacher Baird made the intervention described in the Procedure section. Before the intervention 9D had spent an unproductive seven lessons trying to discover the factors that influence the period of a pendulum. Following the intervention 9C came to this task, and displayed more thoughtful use of the Question-Asking Checklist, and Mr Atkin gave more opportunity for its use. The 9C class did much better at the pendulum task. Three of its groups, nine students, came independently to an insight on the problem that teachers hardly ever discuss, or perhaps even recognize. That is, that the timing of multiple swings to find the average for one swing assumes that amplitude does not affect period. We see this insight as evidence that the students were thinking about what they were doing. We also interpreted many of the conversations and Evaluation Notebook entries as indications that students were thinking about their learning. Examples: Baird: "What do you think are the most

important things you have found out about this experiment?" Student, Grade 9C: "That you have to think about it before you actually go into it." And a Grade 9C Notebook, section C1 of the Checklist:

> Do I fully understand this? No. I do not understand why I got the results I did in the last experiment. Have I read the stopwatch wrongly????? Do I understand enough to justify stopping? I think so. I have understood all results except the last one. What do I have to do in order to achieve full understanding? Redo the last experiment, and if I get the same result, ask! Is it worth doing? Yes. I want to see whether I made an error, and if not, why did I get that result?"

Baird's subjective and retrospective evaluation was that in most lessons up to the intervention students had taken the role defined as category III in the Classification of Student Role scale. Categories II and IV had occasionally been seen. Following the intervention, Baird categorized the lessons in the last weeks of Phase 3 as Grade 9, category II three lessons; III four lessons; IV one lesson; and all Grade 11 lessons as category III. Thus, although there were signs of students thinking more about their learning there was not much change in the teacher's dominance of lessons.

The dominance was recorded in Baird's notes: "... he is still very directive - doesn't allow students to battle with the work and generate their own Q's. - he talks a lot - the Q's he asks have almost always got one, straightforward answer - students remain very

receptive and subordinate." And in Mr Atkin's written evaluations: "Pupils were contributing in a very basic way - little chance for their questions - Again pupil involvement - but mostly on my terms."

Given Mr Atkin's agreement with the aims of the study, we were interested to find why his dominance persisted. Partly it may have been because when he tried to give the students opportunities, he interpreted their reactions as not involving purposeful learning.

> Baird: "How do you think it went?"
>
> Mr Atkin: "Some kids thought they knew the answers, and other kids couldn't work things through, and then they got frustrated when I wouldn't give an opinion, but I was trying to force it back on to them to work it out ... When it was really thrown back on them to make a decision, lots of them just sat there completely dumbfounded and they couldn't either think it through themselves or they couldn't express their thoughts clearly ... Some kids were getting a bit aggravated because when I asked the same question again, the kids couldn't answer it and they said 'You've just asked that' ... It was one of those situations where you have to make a decision and today I made the decision to spend the time with those kids who didn't really know what was going on or couldn't express themselves, and those who thought they understood it had to sit there and wait."

The students suggested that Mr Atkin misunderstood their reactions. First student, 9C: "I couldn't understand it ... Sometimes things get explained in a round-about way, and by the time you understand one thing, you're on to another thing." Baird: "What would you like to see happen differently in the lesson, in order that you understand it better?" Second student: "We told him that we didn't understand it, but he kept going right on, he didn't explain it again, he thought we were just mucking around."

Another reason for the dominance of the teacher was that students were not sure how their questions might be received. Student, 9D: "I don't like asking teachers questions. I feel embarrassed ... I want to ask questions but I just can't ... I might ask them a silly question, and they might think 'Oh! You should know that by now'." Student, 11: "I don't ask questions because I get my head chopped off ... He says 'Oh! You should know!' He doesn't do it to be mean, but you can't ask him too many questions at one hit."

Phase 4. Observations continued in Phase 4 without active training of students in the use of the materials. Improvements in students' control over their learning were seen. Recordings showed that students were asking more of the Checklist questions of the teacher, each other, and Baird. Grade 11 changed more than Grade 9: all Grade 11 students were now recording that they asked themselves five or more Checklist questions in each lesson, while Grade 9 stayed at about the Phase 3 rate. When Phase 4 Notebook entries were compared with early Phase 3 entries, all of the Grade 11 and 80% of the Grade 9 students claimed to be asking more questions. Observations and conversations were consistent with the claim.

There was some evidence of change in control of lessons. From Mr Atkin's written evaluation: "Results of pupils' surveys determined what we did next - student answers determined progress of lesson." A Grade 11 student's written comment: " ... not doing work only as a set task which must be completed, but I have

recently been asking myself questions, e.g., "Why am I doing this? I have also participated in class more." And from a conversation with a Grade 11 student; "Mr Atkin seems to involve the class more and let us ask and answer questions continuously, instead of talking most of the time or giving us a set task."

However, there was still a high degree of teacher dominance. Mr Atkin was aware of that: "I felt the whole lesson dominated by me (Grade 11, week 2), and "Very teacher orientated ... students were keen enough ... but teacher controlled approach to a large degree." (Grade 9C, week 4). Baird rated most lessons as category III on the Student Role scale, throughout Phase 4.

In sum, students had come to greater control of their own learning, but the teacher remained in control of the direction and activities within the lessons.

Other Results

The detailed description above focused on three of the ten objectives, numbers 4 and 7 for the students and number 3 for the teacher. The remaining objectives were much simpler to attain, and the evidence from all sources in the study is clear that they were achieved.

General Conclusion

The procedures followed in this study can give secondary school students greater control over their learning. This leads to greater understanding of content. Change in lesson format, so that students have more say over what is to be learned and how fast new topics should be introduced, is more difficult to bring about. External considerations such as pre-determined syllabus and long-established procedures combine against the change.

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